DESCRIPTION

DECORATIVE SHEET, MOLDED ARTICLE, MOTOR VEHICLE, AND PRODUCTION METHOD OF MOLDED ARTICLE

TECHNICAL FIELD

The present invention relates to a molded article which is decorated, and a production method thereof. The present invention also relates to a decorative sheet used for decorating such a molded article, and a motor vehicle provided with such a molded article.

BACKGROUND ART

Recently, as a technique for decorating various kinds of molded articles, a technique for attaching a decorative sheet onto a surface of a molded article is proposed. The decorative sheet used in this technique is disclosed in Japanese Laid-Open Patent Publication No.10-249999, for example.

The decorative sheet disclosed in the above-identified publication includes a base member and an ink layer formed on a surface of the base member by printing. The decorative sheet is attached to a molded article

with an adhesive. When such a decorative sheet is used, the molded article can be easily recycled as compared with the case of paint application using a coating material. In addition, such a decorative sheet can create beautiful appearance which is different from the paint application, so that a decorative quality can be improved.

A conventional decorative sheet is, however, suitable for the decoration of a molded article having a flat surface, but is not suitable for the decoration of a molded article having an uneven surface. When such a decorative sheet is attached to a molded article having an uneven surface, the decorative sheet is spread so as to follow the unevenness. Therefore, if a pattern of a character, a graphic symbol, a picture, and the like is represented in part of the decorative sheet, the pattern is deformed, and the decorative appearance is uglified.

The present invention has been conducted in view of the above-described problems, and the object of the present invention is to provide a decorative sheet preferably used for the decoration of a molded article having an uneven surface, a molded article to which the decorative sheet is attached, a production method thereof, and a motor vehicle provided with such a molded article.

DISCLOSURE OF INVENTION

The decorative sheet of the present invention includes: a base member, formed from a resin material, having a first and a second principal surfaces opposite to each other; a decoration layer, provided on the first principal surface of the base member, having a pattern area representing a predetermined pattern; and a spread suppressing member, provided in a position corresponding to the pattern area on the side of the first principal surface or on the side of the second principal surface of the base member, for suppressing the spreading of the pattern area of the decoration layer, thereby attaining the above-mentioned object.

In one preferred embodiment, the resin material is a thermoplastic resin material.

In one preferred embodiment, the spread suppressing member has a higher coefficient of thermal conductivity than a coefficient of thermal conductivity of the base member.

In one preferred embodiment, the spread suppressing member is formed from a material including metal or a metal compound.

In one preferred embodiment, the spread suppressing member is formed of metal.

In one preferred embodiment, a coefficient of thermal conductivity of the spread suppressing member is 10 W/m· K or more.

Preferably, a thickness of the spread suppressing member is 5 μm or more and 100 μm or less.

Preferably, the spread suppressing member includes a first portion which overlaps the pattern area.

More preferably, the spread suppressing member includes a second portion positioned in an outer circumference of the first portion.

Preferably, a width of the second portion of the spread suppressing member is 1 mm or more and 10 mm or less.

More preferably, a width of the second portion of the spread suppressing member is 2 mm or more and 8 mm or less.

The molded article according to the present invention includes a molded article body and the decorative sheet with the above-described structure

which is joined to a surface of the molded article body, thereby attaining the above-mentioned object.

In another aspect, the molded article according to the present invention includes: a molded article body; and a sheet joined to a surface of the molded article body, wherein the sheet includes a base member and a decoration layer provided on a face of the base member on the side of the molded article body, the decoration layer has a pattern area representing a predetermined pattern, and a portion of the sheet corresponding to the pattern area has a thickness which is 1.1 times or more and 1.8 times or less as large as a thickness of the other portion of the sheet, thereby attaining the above-mentioned object.

Preferably, the portion of the sheet corresponding to the pattern area has a thickness which is 1.2 times or more and 1.6 times or less as large as the thickness of the other portion of the sheet.

The motor vehicle according to the present invention includes the molded article having the above-described structure, thereby attaining the above-mentioned object.

The production method of a molded article according to the present

invention includes the steps of: preparing a decorative sheet including: a base member, formed from a resin material, having a first and a second principal surfaces opposite to each other; a decoration layer, provided on the first principal surface of the base member, having a pattern area representing a predetermined pattern; and a spread suppressing member, provided in a position corresponding to the pattern area on the side of the first principal surface or on the side of the second principal surface of the base member, for suppressing the spreading of the pattern area of the decoration layer; preparing a molded article body; and joining the decorative sheet to a surface of the molded article body, thereby attaining the above-mentioned object.

In one preferred embodiment, the production method of a molded article according to the present invention includes, before the step of joining the decorative sheet to the surface of the molded article body, the step of heating the decorative sheet.

In one preferred embodiment, the resin material is a thermoplastic resin material.

In one preferred embodiment, the spread suppressing member has a

higher coefficient of thermal conductivity than a coefficient of thermal conductivity of the base member.

In one preferred embodiment, the spread suppressing member is formed form a material including metal or a metal compound.

In one preferred embodiment, the spread suppressing member is formed of metal.

In one preferred embodiment, the coefficient of thermal conductivity of the spread suppressing member is 10 W/m· K or more.

Preferably, a thickness of the spread suppressing member is 5 μm or more and 100 μm or less.

Preferably, the spread suppressing member has a first portion which overlaps the pattern area.

More preferably, the spread suppressing member includes a second portion positioned in an outer circumference of the first portion.

Preferably, a width of the second portion of the spread suppressing member is 1 mm or more and 10 mm or less.

More preferably, a width of the second portion of the spread suppressing member is 2 mm or more and 8 mm or less.

In one preferred embodiment, the step of joining the decorative sheet to the surface of the molded article body includes the step of moving the heated decorative sheet closer to the molded article body, and the step of reducing a pressure of a first space formed between the decorative sheet coming closer to the molded article body and the molded article body as compared with a pressure of a second space expanded oppositely to the first space with respect to the decorative sheet.

In one preferred embodiment, the step of moving the decorative sheet closer to the molded article body is performed in such a manner that the spread suppressing member faces the second space.

In one preferred embodiment, in the production method of a molded article according to the present invention includes, after the step of moving the decorative sheet closer to the molded body, the step of cooling the spread suppressing member by introducing a gas into the second space.

In one preferred embodiment, the production method of a molded article

according to the present invention includes, after the step of joining the decorative sheet to the surface of the molded body, the step of removing the spread suppressing member.

In one preferred embodiment, the spread suppressing member is provided on the side of the second principal surface of the base member.

In one preferred embodiment, after the step of joining the decorative sheet to the surface of the molded article body, the decoration layer is positioned between the base member and the molded article body.

In one preferred embodiment, the molded article body includes a first member and a second member disposed on a surface of the first member, and in the step of joining the decorative sheet to the surface of the molded article body, the decorative sheet is joined to the surface of the molded article body so as to cover both of the first member and the second member, thereby joining the first member and the second member.

In another aspect, the production method of a molded article according to the present invention includes the steps of: preparing a decorative sheet including a base member, formed from a resin material, having a

first and a second principal surfaces opposite to each other, and a decoration layer, provided on the first principal surface of the base member, having a pattern area representing a predetermined pattern; preparing a molded article body; heating the decorative sheet; and joining the decorative sheet which is heated to a surface of the molded article body in a condition where a temperature of a portion of the decorative sheet corresponding to the pattern area is lower than a temperature of the other portion of the decorative sheet, thereby attaining the above-mentioned object.

In one preferred embodiment, the step of joining the decorative sheet to the surface of the molded article body includes the step of cooling the decorative sheet in such a manner that the temperature of the portion corresponding to the pattern area is rapidly lowered as compared with the temperature of the other portion.

In one preferred embodiment, the decorative sheet further includes a member, provided in a position corresponding to the pattern area on the side of the first principal surface or on the side of the second principal surface of the base member, having a higher coefficient of thermal conductivity than a coefficient of thermal conductivity of the base

member.

In one preferred embodiment, the member is formed from a material including metal.

In one preferred embodiment, the member is formed of metal.

In one preferred embodiment, a coefficient of thermal conductivity of the member is 10 W/m· K or more.

The motor vehicle according to the present invention includes the molded article produced by the above-described production method, thereby attaining the above-mentioned object.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1(a)** is a sectional view schematically showing a decorative sheet according to the present invention, and FIG. **1(b)** is a top view schematically showing the decorative sheet according to the present invention.

FIGS. **2(a)** and **(b)** are views showing exemplary patterns represented by

a pattern area of a decoration layer.

FIG. 3 is a sectional view schematically showing another embodiment of a decorative sheet according to the present invention.

FIGS. 4(a), (b), and (c) are views schematically showing one embodiment of the use of the decorative sheet according to the present invention.

FIG. 5 is a view schematically showing a preferred structure of a spread suppressing member.

FIGS. 6(a) and (b) are views schematically showing an embodiment in which the decorative sheet according to the present invention is joined to a molded article body.

FIGS. 7(a) and (b) are views schematically showing another embodiment in which the decorative sheet according to the present invention is joined to a molded article.

FIG. 8 is a sectional view schematically showing a producing apparatus used for producing a molded article with the decorative sheet according to the present invention.

FIG. **9** is a process sectional view schematically showing a production method of a molded article with the decorative sheet according to the present invention.

FIG. **10** is a process sectional view schematically showing a production method of a molded article with the decorative sheet according to the present invention.

FIG. **11** is a process sectional view schematically showing a production method of a molded article with the decorative sheet according to the present invention.

FIG. **12** is a process sectional view schematically showing a production method of a molded article with the decorative sheet according to the present invention.

FIG. **13** is a process sectional view schematically showing a production method of a molded article with the decorative sheet according to the present invention.

FIG. **14** is a process sectional view schematically showing a production method of a molded article with the decorative sheet according to the

present invention.

FIG. **15** is a time chart showing an exemplary time required for a production process.

FIG. **16** is a sectional view schematically showing a molded article.

FIG. **17** is a sectional view schematically showing a molded article.

FIG. **18(a)** and **(b)** are sectional views schematically showing a condition where a decorative sheet is joined to a molded article body having a plurality of members which are separately molded.

FIG. **19** is a view schematically showing a two-wheeled vehicle.

BEST MODE FOR CARRYING OUT THE INVENTION

Hereinafter embodiments of the present invention will be described with reference to the accompanying drawings. The present invention is not limited to the embodiments described below.

A decorative sheet **10** in this embodiment is schematically shown in FIGS. **1(a)** and **(b)**. The decorative sheet **10** includes, as shown in FIGS.

1(a) and (b), a base member 1 having a first principal surface 1a and a second principal surface 1b which are opposite to each other, and a decoration layer 2 provided on the first principal surface 1a of the base member 1.

The base member 1 is formed from a resin material, and typically formed from a thermoplastic resin material. The decoration layer 2 is formed from ink, or the like. The decoration layer 2 includes a pattern area 2a representing a predetermined pattern. The pattern represented by the pattern area 2a is concretely a design such as a diagram, a color-coding, or gradation, and more concretely a character shown in FIG. 2(a), a graphic symbol shown in FIG. 2(b), or a picture.

FIGS. 1(a) and (b) show a case where the decoration layer 2 having the pattern area 2a in an entire face thereof is provided on part of the principal surface 1a. Alternatively, as shown in FIG. 3, the decoration layer 2 having the pattern area 2a only in part may be provided on the entire face of the principal surface 1a. An area 2b other than the pattern area 2a of the decoration layer 2 is a monotone area without any pattern, for example.

FIGS. **4(a)**, **(b)**, and **(c)** show examples of the use of the decorative sheet **10**. The decorative sheet **10** is joined to the surface of a molded article body **21**, so as to decorate the molded article **20**, as shown in FIGS. **4(a)**, **(b)**, and **(c)**. The decoration layer **2** has a pattern area **2a**, so that high decorating effects can be attained, as compared with a decoration layer having no pattern area **2a** (a monotone decoration layer without any pattern as a whole, for example). In other words, the pattern area **2a** is an area of which accuracy as decoration is more highly required than the other area of the decoration layer **2** after the joining to the molded article body **21**.

The molded article body **21** shown in FIG. **4(a)** has a protruding portion **21a** of a hemispherical shape (a bowl-like shape), and the surface is uneven. Therefore, when the decorative sheet **10** is to be joined, the decorative sheet **10** is spread so as to follow the unevenness. In order to preferably perform the spread of the decorative sheet **10**, typically, the joining is performed after the decorative sheet **10** is heated and softened.

The decorative sheet **10** according to the present invention is provided with a spread suppressing member **3** for suppressing the spread of the pattern area **2a**, as shown in FIGS. **1(a)** and **(b)**, and FIG. **3**. The spread

suppressing member **3** is provided in a position corresponding to the pattern area **2a**. The spread suppressing member **3** in this embodiment is provided so as to overlap the pattern area **2a** on the side of the second principal surface **1b** of the base member **1** (on the side opposite to the side on which the decoration layer **2** is provided).

The spread suppressing member **3** is a member with lower spreading property than that of the base member **1**, for example, so that the spread of the pattern region **2a** is suppressed.

Alternatively, the spread suppressing member **3** has a higher coefficient of thermal conductivity than a coefficient of thermal conductivity of the base member **1**, so that the spread of the pattern area **2a** is suppressed. If the coefficient of thermal conductivity of the spread suppressing member **3** is higher than the coefficient of thermal conductivity of the base member **1**, a temperature of a portion of the decorative sheet **10** on which the spread suppressing member **3** is provided lowers more rapidly than the other portion after the heating. Thus, the spreading property is lowered as compared with the other portion. Therefore, the spreading of the pattern area **2a** is suppressed.

It is understood that the spread suppressing member **3** preferably has both of the above-described two physical properties, in order to effectively suppress the spread of the pattern region **2a**.

If the joining as shown in FIGS. **4(a)** to **(c)** is performed by using a conventional decorative sheet, the pattern such as a character, a graphic symbol, or a picture is deformed, so that the beautiful appearance of the molded article is uglified.

On the contrary, the decorative sheet **10** according to the present invention includes the spread suppressing member **3**, so that the spread of the pattern region **2a** in joining to the molded article body **21** can be suppressed. Therefore, when the decoration of the molded article is performed by using the decorative sheet **10** according to the present invention, the deformation of the pattern can be prevented, and beautiful appearance can be attained. The spread suppressing member **3** is provided so as to overlap only part of the principal surface **1b** of the base member **1** in accordance with the pattern area **2a** (that is, provided partially with respect to the principal surface of the base member **1**), so that the following property of the decorative sheet **10** for the unevenness of the surface of the molded article body **21** is hardly degraded.

Hereinafter, preferable materials, structures, and layouts of the spread suppressing member **3**, the decoration layer **2**, and the base member **1** will be described.

As a material for the spread suppressing member **3**, metal such as aluminum, copper, stainless can be preferably used. As the spread suppressing member **3**, a foil, a film, a thin plate, or the like formed of any one of the above-mentioned metals may be preferably used. Generally, a coefficient of thermal conductivity of metal is higher than a coefficient of thermal conductivity of a resin by two or three digits. For this reason, if metal is used as the material for the spread suppressing member **3**, the coefficient of thermal conductivity of the spread suppressing member **3** can be sufficiently higher than the coefficient of thermal conductivity of the base member **1** formed from a resin material. Therefore, it is easy to rapidly lower the temperature of the portion of the decorative sheet **10** in which the spread suppressing member **3** is provided. Thus, it is possible to effectively suppress the spread of the pattern area **2a**.

The spread suppressing member **3** is not limited to that formed of metal. Since metal or a metal compound has a much higher coefficient of

thermal conductivity than that of a resin, the coefficient of thermal conductivity of the spread suppressing member **3** can be higher than the coefficient of thermal conductivity of the base member **1** by using a material including metal or a metal compound. As a material including metal or a metal compound, for example, a material in which filler (inorganic filler) formed from metal or a metal compound is dispersedly mixed in a resin matrix is listed. As a metal compound which constitutes filler, for example, a metal oxide such as alumina can be used.

In order to rapidly lower the temperature of the portion of the decorative sheet **10** in which the spread suppressing member **3** is provided, and to effectively suppress the spread of the pattern region **2a**, the coefficient of thermal conductivity of the spread suppressing member **3** is preferably equal to or 50 times, and more preferably equal to or 100 times as compared with the coefficient of thermal conductivity of the base member **1**. Specifically, the coefficient of thermal conductivity of the spread suppressing member **3** is preferably 10 W/m· K or more, more preferably 15 W/m· K or more, and much more preferably 20 W/m· K. The coefficient of thermal conductivity of a resin material is about 0.2

(the coefficient of thermal conductivity of polycarbonate is 0.19 W/m · K, and the coefficient of thermal conductivity of acryl resin is 0.2 W/m · K, for example). On the contrary, the coefficient of thermal conductivity of alumina is 21 W/m · K, and the coefficient of thermal conductivity of aluminum is 236 W/m · K.

Alternatively, as the material for the spread suppressing member **3**, a resin material can be used. If a resin material having a higher deflection temperature under load (a heat deflection temperature) than that of a resin material which forms the base member **1**, or a resin material having higher rigidity than that of a resin material which forms the base member **1**, is used, the spreading property of the spread suppressing member **3** can be lower than that of the base member **1**, so that the spread of the pattern region **2a** can be suppressed.

A thickness of the spread suppressing member **3** is preferably 5 μm or more and 100 μm or less. If the thickness is lower than 5 μm, the strength is failed, and deformation or breakage may occur. If the thickness exceeds 100 μm, in the case where metal is used as the material, the following property of the spread suppressing member **3** with respect to the unevenness (convex and concave) of the molded

article body **21** is sometimes insufficient. Thus, there is a fear that the spread suppressing member **3** may be peeled off in joining.

As shown in FIG. **5**, the spread suppressing member **3** preferably has a portion which overlaps the pattern area **2a** (an overlap portion) **3a**. When the spread suppressing member **3** has such an overlap portion **3a**, the effect for suppressing the spread can be directly attained for the pattern area **2a**. Thus, the spreading of the pattern area **2a** can be effectively suppressed.

As shown in the figure, when the spread suppressing member **3** also has a portion **3b** which is positioned in an outer circumference of the overlap portion **3a** (an outer circumference portion), the spreading of the pattern area **2a** can be more surely suppressed. From the point of view that the spreading of the pattern area **2a** is effectively suppressed, and the spreading of the portion other than the pattern area **2a** is not prevented, the width of the outer circumference portion **3b** of the spread suppressing member **3** is preferably 1 mm or more and 10 mm or less, and more preferably 2 mm or more and 8 mm or less.

Even if the spread suppressing member **3** does not include a portion

overlapping the pattern area **2a**, but has a frame-like shape fringing the pattern area **2a**, the spreading of the pattern area **2a** can be suppressed. However, as shown in FIG. **5**, the case where the spread suppressing member **3** has the portion **3a** overlapping the pattern area **2a** can attain higher effect for suppressing the spreading of the pattern area **2a**.

As a material of the decoration layer **2**, ink including a resin material as a binder and pigment dispersed in the resin material can be used, for example. The decoration layer **2** can be formed by printing with such ink. The material of the decoration layer **2** is preferably superior in heat resistance and flexibility. The ink disclosed in Japanese Laid-Open Patent Publication No.2002-275405 has superior heat resistance and flexibility, so that the ink can be preferably used as the material for the decoration layer **2**.

As a resin material which forms the base member **1**, a thermoplastic resin material can be suitably used, as described above. More specifically, polycarbonate (PC), acrylic resin, polyethylene terephthalate (PET), urethane resin, or the like can be preferably used. However, since the base member **1** is required to have rigidity as a sheet base member, it is preferred that a resin material be selected in

consideration of this point. Although a thermosetting resin material can be used as the resin material which forms the base member **1**, it is preferred that a thermoplastic resin material be used in view of the formability of the decorative sheet **10**.

A thickness of the base member **1** is preferably 100 μm or more and 1000 μm or less. If the thickness of the base member **1** is less than 100 μm, it is difficult to handle the base member as a sheet, or there may occur a disadvantageous case where the strength is not sufficient and breakage occurs in joining. If the thickness of the base member **1** exceeds 1000 μm, the following property with respect to the surface of the molded article body **21** may be deteriorated.

The joining of the decorative sheet **10** may be performed, as shown in FIG. **6(a)**, in such a manner that the first principal surface **1a** on which the decoration layer **2** is provided faces the molded article body **21**, or alternatively as shown in FIG. **6(b)**, in such a manner that the second principal surface **1b** on the opposite side to the first principal surface **1a** faces the molded article body **21**.

The spread suppressing member **3** may be provided, as shown in FIGS.

6(a) and (b), on the side of the second principal surface 1b of the base member 1 (the side on which the decoration layer 2 is not provided), or alternatively provided, as shown in FIGS. 7(a) and (b), on the side of the first principal surface 1a of the base member 1 (the side on which the decoration layer 2 is provided). In the case where the spread suppressing member 3 is provided on the side of the first principal surface 1a, after the decoration layer 2 is formed on the spread suppressing member 3 by printing or other means, the accumulated body may be provided on the first principal surface 1a of the base member 1. Alternatively, the spread suppressing member 3 may be provided on both sides of the first principal surface 1a and the second principal surface 1b of the base member 1.

As shown in FIG. 6(a) and FIG. 7(a), when the joining is performed in such a manner that the first principal surface 1a on which the decoration layer 2 is provided faces the molded article body 21, the decoration layer 2 is positioned between the base member 1 and the molded article body 21 in the completed molded article, so that the decoration layer 2 can be advantageously protected by the base member 1.

On the other hand, as shown in FIG. 6(b) and FIG. 7(b), when the

joining is performed in such a manner that the second principal surface **1b** faces the molded article body **21**, the decoration layer **2** is positioned on the outer side than the base member **1**. Therefore, there is an advantage that in addition to a transparent resin material or a translucent resin material, an opaque resin material can be preferably used as the resin material for forming the base member **1**.

As shown in FIG. **6(a)** and FIG. **7(b)**, when the joining is performed in such a manner that the spread suppressing member **3** is positioned on the side opposite to the molded article body **21** with respect to the base member **1**, it is possible to remove the spread suppressing member **3** after the joining. It is possible to prevent the beautiful appearance from being deteriorated because the spread suppressing member **3** remains in the completed molded article. In addition, it is possible to neglect the contribution of the spread suppressing member **3** to decoration in the completed molded article, so that the material for the spread suppressing member **3** can be more freely selected (it is unnecessary to use a transparent or translucent material, for example). Thus, it is possible to preferably use various materials such as metal.

Especially when the spread suppressing member **3** is provided on the

side of the second principal surface **1b** of the base member **1** (on the side opposite to the side on which the decoration layer **2** is provided), and the joining is performed in such a manner that the first principal surface **1a** on which the decoration layer **2** is provided faces the molded article body **21**, as shown in FIG. **6(a)**, both of the advantages that the decoration layer **2** can be protected by the base member **1** and that it is possible to remove the spread suppressing member **3**. Thus, large merits in practical use can be attained.

For the fixing of the spread suppressing member **3** and the decorative sheet **10**, an adhesive is used, for example. As an adhesive, a thermoplastic resin (thermoplastic polyurethane resin or thermoplastic acrylic resin) can be used, or a thermosetting resin (an epoxy resin, for example) can be used. When the decorative sheet **10** is heated before the joining, the adhesive preferably has high heat resistance. In the case where the spread suppressing member **3** is removed after the joining, it is preferred that the adhesive used for joining the spread suppressing member **3** be easily peeled off. As an adhesive which has high heat resistance and which can be easily peeled off, an adhesive of silicone type is listed specifically.

Next, a production method of a molded article using the decorative sheet **10** and a production apparatus used in the production method will be described.

First, a production apparatus **100** for the molded article is described with reference to FIG. **8**. The production apparatus **100** includes, as shown in FIG. **8**, a holding device (a holding frame) **30** for holding the decorative sheet **10**, a supporting device (a supporting table) **31** for supporting the molded article body **21**, a pressurizing box **32** positioned above the holding device **30** and the supporting device **31**, a sealing cylinder **33** for moving up and down the pressurizing box **32**, a pressurizing rubber hose **34** for introducing a gas into a space below the pressurizing box **32**, a heater (a far infrared heater, for example) **35** for heating the decorative sheet **10**, and a vacuum vessel **36** for accommodating them.

The vacuum vessel **36** includes a first vessel **36a** for accommodating the holding device **30**, the supporting device **31**, the box **32**, the cylinder **33**, and the rubber hose **34**, and a second vessel **36b** for accommodating the heater **35**. The heater **35** may be introduced into the first vessel **36a** via a door **37**, if required.

The supporting device **31** has a plurality of openings **31a**. With a vacuum pump which is externally provided, the atmospheric air is sucked through the openings **31a**, thereby realizing a reduced pressure (evacuation) of the space spreading over the supporting device **31**. The rubber hose **34** is connected to the outside. By introducing a gas through the rubber hose **34**, the space spreading below the box **32** can be pressurized.

Next, with reference to FIGS. **9** to **15**, a production method of a molded article utilizing the decorative sheet **10** will be described. FIGS. **9** to **14** are process sectional views schematically showing the production method of the molded article. FIG. **15** is a time chart showing an example of periods of time required for respective steps.

First, the decorative sheet **10** such as shown in FIG. **1** is prepared. The decorative sheet **10** can be prepared from the above-described materials by known techniques. For example, the decorative sheet **10** can be prepared in such a manner that a decoration layer **2** is formed by printing with ink on a first principal surface **1a** of a base member **1**, and a spread suppressing member **3** is fixed with an adhesive on the side of a second principal surface **1b** of the base member **1**.

In a separate step from the step of preparing the decorative sheet **10**, a molded article body **21** is prepared. The molded article body **21** may be formed from a resin material, or may be formed from a metal material. Alternatively, the molded article body **21** may be formed from the other materials (formed of wood, for example). The molded article body **21** may be transparent, opaque, or translucent. The molded article body **21** can be prepared by a known technique. In the case where a resin material is used, the molded article body **21** can be prepared by injection molding, for example. As the resin material, both of a thermoplastic resin and a thermosetting resin can be used. Specifically, an unsaturated polyester resin, an epoxy resin, a vinyl ester resin, a polyurethane resin, and the like can be used.

Next, as shown in FIG. **9**, the molded article body **21** is placed on the supporting device **31**, and the decorative sheet **10** is fixed to the holding device **30** so that the decorative sheet **10** is positioned above the molded article body **21**. At this time, an adhesive is applied to a surface of the decorative sheet **10** on the side of the molded article body **21**. In this embodiment, thereafter, the air in the vacuum vessel **35** is sucked through the openings **31a** of the supporting device **31** by means of the

vacuum pump which is externally provided. Thus, the pressure in the inside of the vacuum vessel **35** is preliminarily reduced. As the result of the pressure reduction, the internal pressure of the vacuum vessel **35** is 2.7 kPa or less, for example.

Next, as shown in FIG. **10**, the decorative sheet **10** is heated by means of the heater **35**, thereby softening the decorative sheet **10**. At this time, the decorative sheet **10** is typically heated up to temperatures equal to or higher than a deflection temperature under load of the resin material which forms the base member **1**. If the heating temperature is too low, it is difficult to deform the resin material. Therefore, the resin material may be broken in shaping (in attaching), or the shaping itself cannot be performed. If the heating temperature is too high, sags of sheet in heating remarkably occur, so that it is difficult to perform the shaping, or the appearance may be degraded because of air bubbles in the resin material. Therefore, it is preferred that the heating temperature be appropriately set in accordance with the kind of the resin material of the base member **1**. When polycarbonate is used as the resin material for forming the base member **1**, the decorative sheet **10** is heated up to about 195℃, for example. The movement of the heater **35** from the second

vessel **36b** to the first vessel **36a** is performed in about 3 to 5 seconds, for example. The heating by the heater **35** is performed for about 15 to 30 seconds, for example.

Thereafter, as shown in FIG. **11**, the pressurizing box **32** and the holding device **30** are moved downwardly by the cylinder **33**, so that the decorative sheet **10** comes closer to the molded article body **21**. The downward movement is performed in about 1 to 2 seconds, for example. In this embodiment, the decorative sheet **10** is moved downwardly. Alternatively, the supporting device **31** for supporting the molded article body **21** may be moved upwardly, so that the decorative sheet **10** comes closer to the molded article body **21**.

Next, as shown in FIG. **12**, a pressure of a first space formed between the decorative sheet **10** and the molded article body **21** is more reduced than a pressure of a second space expanded on the opposite side to the first space with respect to the decorative sheet **10** (that is, a space formed between the decorative sheet **10** and the pressurizing box **32**). As a result, the decorative sheet **10** is joined to the molded article body **21**, as shown in FIG. **13**.

Specifically, together with the reduction of pressure in the first space by means of the vacuum pump, a gas is introduced into the box **32** through the rubber hose **34**, so as to pressurize the second space. As a result, the decorative sheet **10** is pressed against the molded article body **21** with a substantially uniform pressure, thereby joining the decorative sheet **10** to the molded article body **21**. The pressure reduction in the first space is performed, so that the internal pressure of the first space is 2.7 kPa or less, for example. The pressurizing of the second space is performed, so that the internal pressure of the second space is about 0.2 MPa to 0.5 MPa. The reduced pressure condition of the first space and the pressurized condition of the second space are retained for a predetermined period of time (for 15 seconds or more, for example). A temperature of the gas (the air, for example) introduced into the second space is about a room temperature (15℃ to 30℃), for example.

Next, the vacuum vessel **35** is opened, so that the internal pressure of the vacuum vessel **35** is returned to be the atmospheric pressure. Unnecessary portions of the decorative sheet **10** are cut (trimmed) with cutting means such as a rotary blade. Thereafter, the molded article body **21** is released from the supporting device **30**, thereby completing a

molded article **20**, as shown in FIG. **14**.

According to the above-described production method, it is possible to perform the joining of the decorative sheet **10** to the molded article body **21** (that is, the figuration of the decorative sheet **10**) in a very short period of time (in 1 second or less, as exemplarily described). In addition, in joining, the decorative sheet **10** is entirely spread, but the spreading of the pattern portion **2a** of the decoration layer **2** is suppressed by means of the spread suppressing member **3**. Therefore, the distortion of pattern is prevented, and the beauty in appearance is not deteriorated.

When the spreading property of the spread suppressing member **3** is poorer than the spreading property of the base member **1**, the spreading of the pattern portion **2a** is suppressed for this reason. When the coefficient of thermal conductivity of the spread suppressing member **3** is higher than the coefficient of thermal conductivity of the base member **1**, the temperature of the portion of the decorative sheet **10** in which the spread suppressing member **3** is provided (that is, the portion corresponding to the pattern area **2a**) more rapidly lowers than the temperature of the other portion of the decorative sheet **10**. Therefore,

the joining of the decorative sheet **10** is performed in a condition where the temperature of the portion of the decorative sheet **10** corresponding to the pattern area **2a** is lower than the temperature of the other portion of the decorative sheet **10**. Therefore, the spreading of the pattern portion **2a** is suppressed.

When the heating by the heater **35** is stopped, the decorative sheet **10** is naturally cooled (allowed to cool). As a result, the above-described non-uniform temperature distribution of the decorative sheet **10** can be realized. Alternatively, more positive cooling may be performed. When the gas is introduced into the second space in joining, as in this embodiment, the introduced gas can not only pressurize the second space, but also cool the surface of the decorative sheet **10** on the side of the second space. Therefore, when the spread suppressing member **3** faces the second space, the spread suppressing member **3** is cooled by the gas, so that the above-described non-uniform temperature distribution can be rapidly realized. Therefore, even in the case where the joining is performed in a very short time as described above, the spreading of the pattern area **2a** can be more surely suppressed.

In the case where the joining is performed so that the spread suppressing

member **3** faces the second space, the spread suppressing member **3** may be removed from the molded article **20** if necessary. If the fixing of the spread suppressing member **3** is performed by means of an adhesive which can be easily peeled off, the removal can be preferably performed.

It is not necessarily that the spread suppressing member **3** is directly in contact with the first principal surface **1a** or the second principal surface **1b** of the base member **1**. The adhesive layer typically exists between the base member **1** and the spread suppressing member **3**, and additionally, another layer may be interposed. FIG. **16** is a partially enlarged view of an example of the sectional structure after the joining.

In the structure exemplarily shown in FIG. **16**, on the second principal surface **1b** of the base member **1** formed from polycarbonate, a protecting layer **8** of an acrylic resin is formed. On the protecting layer **8**, the spread suppressing member **3** formed of aluminum is provided with the adhesive layer **9** interposed therebetween. The protecting layer **8** is positioned on the outer side than the base member **1** in the molded article **20**, so that the protecting layer **8** protects the base member **1** and improves the weather resistance of the decorative sheet **10**. The base member **1** has a thickness of 200 μm to 1000 μm, for example. The

protecting layer **8** has a thickness of 5 μm to 50 μm, for example. The spread suppressing member **3** has a thickness of 5 μm to 100 μmm, for example. The adhesive layer **9** has a thickness of 5 μm to 50 μm, for example.

As shown in FIG. **16**, on the first principal surface **1a** of the base member **1**, the decoration layer **2** formed of ink is provided. On the decoration layer **2**, a metal layer **6** formed from tin is provided with the adhesive layer **7** interposed therebetween. Since the metal layer **6** has metallic luster, the decorative sheet **10** can exhibit colors of metallic tones (metallic color) having metallic appearance. Herein, the metal layer **6** is formed in such a manner that tin is evaporated on a carrier film **5**, and the layered body is attached to the first principal surface **1a** with an adhesive. The decoration layer **2** has a thickness of 5 μm to 50 μm, for example. The metal layer **6** has a thickness of 0.25 μm to 0.8 μm, for example, and is formed from soft metal such as tin.

The decorative sheet **10** shown in FIG. **16** is joined to the molded article body **21** by means of the adhesive layer **4**. The adhesive layer **4** has a thickness of 5 μm to 50 μm, for example. As described above, the spread suppressing member **3** may be provided on the side of the first

principal surface **1a** of the base member **1**. More specifically, as shown by a dot line in FIG. **16**, on the first principal surface **1a** of the base member **1**, the spread suppressing member **3** may be provided with the decoration layer **2**, the adhesive layer **7**, the metal layer **6**, and the carrier film **5** interposed therebetween.

In order to maintain the decorating effect of the pattern area **2a** of the decoration layer **2** high, as shown in FIG. **17**, the thickness T_1 of the portion of the sheet **10** corresponding to the pattern area **2a** is preferably 1.1 times or more and 1.8 times or less as large as the thickness T_2 of the other portion of the sheet **10**. More preferably, the thickness T_1 is 1.2 times or more and 1.6 time or less as large as the thickness T_2. When the pattern area **2a** is such thin that the thickness T_1 is less than 1.1 times as large as the thickness T_2, stepped cut may occur in the pattern area **2a** due to the unevenness of the surface of the molded article body **21**, and desired decorating effects cannot be attained. When the thickness T_1 is more than 1.8 times as large as the thickness T_2, the appearance of the pattern area **2a** may be distorted due to the lens effect, or the portion corresponding to the pattern area **2a** (the portion is raised as compared with the other portion) may get scratched by friction.

In this embodiment, the molded article body **21** which is integrally formed (in other words, which has a single member) is shown. Alternatively, a molded article may have a plurality of members which are separately molded, and the plurality of members may be mutually coupled by the joining of the decorative sheet **10**.

Specifically, as shown in FIG. **18(a)**, on a surface of a molded article body **22** having a first member **22a** and a second member **22b** disposed on a surface of the first member **22a**, the decorative sheet **10** is joined so as to cover both of the first member **22a** and the second member **22b**. As a result, as shown in FIG. **18(b)**, a molded article **20'** in which the first member **22a** and the second member **22b** are coupled can be obtained.

A relative positional relationship between the first member **22a** and the second member **22b** can be arbitrarily selected. For this reason, when the plurality of members **22a** and **22b** of the molded article body **22** are coupled by means of the joining of the decorative sheet **10**, as described above, a large variety of shapes of molded articles can be obtained by using a relatively small number of molding dies. Therefore, the production of the large variety of shapes of molded articles can be easily performed at a low cost. For the first member **22a** and the second

member **22b**, a structure for temporarily tacking them, that is, a positioning structure for determining the relative positional relationship can be provided. The positioning structure may be a protruding portion and a concave portion which are mutually engaged, for example.

The molded article produced by the production method using the decorative sheet **10** is suitably used for interior or exterior of motor vehicles, exterior of home electric appliances, and the like. For example, the molded article is suitably used as a tank cover **51**, a front fender **52**, and a tail cowl **53** of a motorbike **50** shown in FIG. **19**. As we all known, the "motor vehicles" widely indicate loco mobile conveyances or machines for transporting passengers or merchandises, or for moving things, and include a car, a motorbike, a bus, a truck, a tractor, an airplane, a motorboat, a civil engineering vehicle, and the like. The motor vehicles include not only those provided with an internal combustion engine such as a gasoline engine, but also those provided with an electric motor.

INDUSTRIAL APPLICABILITY

According to the decorative sheet of the present invention, since the spread suppressing member for suppressing the spreading of the pattern

area is provided in a position corresponding to the pattern area of the decoration layer, the spreading of the pattern area in the joining to the molded article body can be suppressed. Accordingly, the decorative sheet according to the present invention can be preferably used for the decoration of a molded article of which the surface has unevenness. When the production of the molded article is performed by using the decorative sheet according to the present invention, distortion of pattern can be prevented, and the obtained molded article has beautiful appearance.

The molded article which is produced by using the decorative sheet according to the present invention is preferably used for various goods, and especially preferably used for interior and exterior of a motor vehicle.